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OF THE BLACKFEET INDIANS:

A REASSESSMENT OF BOAS'

NATIVE AMERICAN DATA

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Comparisons in the cranial form of the Blackfeet Indians: A reassessment of Boas' Native American Data

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Abstract: Franz Boas proposed almost one hundred yeas ago that cranial plasticity explained the differences in cranial form between European-born immigrants and their American-born children. Plasticity refers to the idea that the body responds to environmental forces during growth and development. If the environment does affect cranial growth and development, than differences should be seen in populations living under different ecological conditions. In this study anthropometric measurements will be used to test for differences in head and face measurements of members of the Blackfeet Nation using multivariate statistics. The tests are designed to detect differences between the three tribes of the Blackfeet Nation (the Piegan, the Blood, and the Blackfeet). Blackfeet children sent to the Carlisle Indian School in Carlisle, PA are compared to the children that remained on the reservations. Lastly, this study examines the overall changes in the Blackfeet peoples throughout the nineteenth century as they were forced to change from nomadic hunter-gatherers to sedentary farmers living under Anglo-American policy on restricted lands.

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CHAPTER I: INTRODUCTION

The early twentieth century saw an increase in the number of immigrants from Eastern and Southern Europe entering the United States leading to an increase in social pressures on the United States. The Immigration Commission was established by the United States Government in New York to address these problems. Franz Boas began communication with them in 1908 hoping to obtain funds for a study to test if these new populations would have an effect on the existing American population; which was primarily perceived to be the tall, blond, northwestern European type (Sparks and Jantz, 2003). He also noticed differences in Americans who had immigrated earlier and their newly immigrated European counterparts and wanted to test if the American environment had any influences on the differences he was seeing. The Immigration Commission was more interested in looking at the social and economic aspects of assimilation but was convinced by Boas that his study would account for all of that and more.

Boas began his study initially looking at the assimilation of new immigrants to that of the American population at the time, but over time the direction of his study changed to looking at how waves of immigrants from the same country differed from each other, and how American-born children differed from their foreign-born parents (Kaplan, 1954). He collected data on almost 18,000 individuals from seven Eastern European nationalities. Boas' full report was published in 1912. In this report Boas came to two main conclusions; that American-born descendants of immigrants differ in type from their foreign-born parents, and the effects of the American environment

increase with an increase between the length of time of the mother's arrival in America and the birth of her child (Boas, 1912).

Before Boas, other disciplines already recognized that living organisms are plastic. Scientist studying animals saw that members of the same species living in varying climates showed marked differences from each other (Kaplan, 1954). Physical anthropology, at the time, was not concerned about the effects the environment had on humans, they were more interested in proving evolution and ending the "race" concept. Plus the idea of plasticity in craniofacial morphology brought many complications and critics. Before Boas, cranial dimensions were thought to be stable. They were not affected by culture or environment rather they were inherited (Kaplan, 1954). Once it was demonstrated that factors other than genetics influenced phenotype it became necessary to explain trends in the history of human development. Were these changes secular or evolutionary? It could be argued that these changes are not evolutionary because there is no evidence that shows changes in gene structure. Rather these changes are due to a response to a more favorable environment. This does not mean that environmental factors change genetic makeup but instead it is a response of the individual to external conditions. So what is the limit of human plasticity? Boas and his followers state that the plasticity of the human organism is limited by the genetic potential of each individual (Kaplan, 1954).

There is still little agreement today about what postgenetic factors are responsible for changes in the cranium. The idea that the environment plays a play factor in cranial form leads to many more questions. To what extent do environmental forces control cranial growth and development? What types of changes, if any can be seen or

measured, are based on environmental factors? Are we able to tell where an individual was born and raised based on cranial measurements? Finding these answers can aid in many areas of physical anthropology including forensic anthropology, population studies, and paleoanthropology. Some anthropologists are now starting to look for these answers (Gravlee, 2003; Jantz and Meadows Jantz, 2000; Sparks and Jantz 2002; Szathmary, 1995; Wescott and Jantz, 1999).

In order to address this question, this research will focus on Boas' data collected in the late nineteenth century from the three tribes that make up the Blackfeet Nation: the Blackfeet, the Blood, and the Piegan. First, differences between the three tribes will be examined. Can differences between the Piegan living in Montana and the Blood and the Blackfeet living north of them in Canada be seen? Would there be enough differences in the environment between Canada and the Northern Plains to cause differences in cranial form? Were these tribes in close enough contact with each other to share genes making them genetically similar to each other or did they strictly mate only within their individual tribes which would cause them to be further apart genetically? Or were these tribes close enough in environment and genetics that no differences can be seen? Also, the differences between the children who were measured on the reservations both in Montana and Canada and between the children who were measured in Carlisle, Pennsylvania at the Indian Industrial School will be examined. Did taking these kids to a different part of the country and supplying them with different resources change the growth of their heads and faces? Would raising them in more of an "American" way lead to differences in their growth and development versus their counterparts who were left on the reservations? Lastly, does a change in overall lifestyle change the measurements of

the head and face? Did the end of a nomadic hunting life affect the growth and development of the cranium? Unlike other Native American tribes who were forced west by white expansion the Blackfeet have always roamed the Northwest Plains of Canada and Montana. If differences can be seen over time they would most likely be caused by a change in overall lifestyle rather than a change in the environment.

This information could aid in population studies. It could help to assess when certain populations moved to a certain area and how long they lived there based on changes to the cranium. It would also lead to a better understanding of how Native American groups are related to each other and their settlement patterns.

This knowledge would also be useful in a forensic setting. Right now individuals are identified using broad racial groups, White, Black, Native American, and Asian. Understanding how and what effects the environment has on the size and shape of the crania may help in pinpointing what part of the world an individual was born and raised.

This research may also aid in paleoanthropology. To date there are very limited hominid samples and there is a trend to treat specimens as different species based on cranial morphology. If there was an understanding of the effects the environment has had on modern humans over the last few hundred years, new conclusions may be drawn about the environments' effect on our evolution and taxonomic studies. Just think, if there is a change in cranial morphology in a short time in a relatively controllable environment, imagine what changes might have taken place over a hundreds of years in an environment that is difficult to identify.

This study used data observed on 217 individuals from the Blackfeet Nation, one hundred forty-seven of who are children. The data also consists of six measurements

observed on the living individuals (head length, head breadth, face height, face breadth, nose height, and nose breadth). Biological and genetic distances among the tribes were estimated using RMET 5.0. Also, measurements of head length, head breadth, and cranial index were compared to see if differences exist between the children at the Carlisle Indian Industrial School and children on the reservation, and if there is an overall change in those measurements through time.

HISTORY OF THE BLACKFEET

The Blackfeet Nation is comprised of three tribes, the Siksika (Blackfeet), the Kanai (Blood), and the Pikuni (Piegans). The three groups have the same customs and language (Algonquin) but are politically independent. The term "Blackfeet" most likely comes from the coloring on their feet caused by the dark soil or burnt prairie land they moved across (Hungry Wolf, 1989).

It is commonly thought that the Blackfeet were the earliest arrivals to the Northwest Plains. The Blackfeet believe that Napi, "Old Man," created them right in the heart of buffalo country (Raczka, 1979). By 1800, with the recent arrival of guns and horses, the Blackfeet were at their greatest power, inhabiting the country from the Saskatchewan River in the North to the Yellowstone River in the South, and from the Rocky Mountains in the West to the Missouri River in the East (Grinnell, 1892).

The Blackfeet were hunter-gatherers, moving around the plains, following the herds of bison, their main diet. They also hunted elk, mountain sheep, and antelope, and collected berries and roots. They did very little farming planting only some tobacco and camas roots (Forbes, 1936). They traveled in small bands coming together throughout

the year for ceremonies. Their homes were conical shaped structures that were covered with animal hides for warmth. These houses could be easily folded down to be moved on travois by dogs, their main pack animal until the introduction of the horse (Grinnell, 1892).

The three tribes were rivals but not enemies. They commonly intermarried and helped each other out when needed but tried to keep their individual tribal identities (Farr, 1984). Marriage among the Blackfeet was exogamous, meaning they married outside of their bands. It was also looked at as a way to gain status. Grooms paid a bride wealth making daughters a valuable asset. The Blackfeet practiced polygyny with a man marrying sisters. Divorce was tolerated but adultery was not. To get divorced, the women would move her possessions back into her father's house leaving her children with their father. If a woman was caught committing adultery it would cost her nose and ostracism, possibly even her life. Wife stealing was also taboo within Blackfeet society but women could be given to another man as a gift (Forbes, 1936).

Protecting their resources was one of the Blackfeet's main priorities (Forbes, 1936). They would often raid their neighboring tribes the Shoshone (Snake), the Salish, the Kootenai, the Crows, the Assiniboine, and the Cree for resources including horses, guns, women, and children (Raczka, 1979). With the introduction of the horse and gun in the late 1700s, and eventually whiskey, the Blackfeet became even more feared.

Before the late 1700's there is little written history on the Blackfeet. They had no contact with white trappers and traders that were now beginning to move into their territory. Although their contact with outsiders was nonexistent, other neighboring tribes were willing to work with the traders moving into the unexplored wildernesses of

Montana and Canada, swapping furs for horses and guns. Because of this contact, epidemics of smallpox were inevitable, often depleting the Blackfeet's numbers by half (Raczka, 1979). After these times, the Blackfeet would raid their neighbors, killing the men, and taking the women and children to help restore their numbers.

In 1780, the Hudson Bay Company built the trading post Buckingham House on the Saskatchewan River. This was the first post close to the Blackfeet (Hungry Wolf, 1989). Although they did not trade directly with the Blackfeet, the traders frequently had contact with the Cree and Assiniboine, who in turn would trade guns and horses to the Blackfeet for more hides. The men working for the Hudson Bay Co. were aware of their individual looks and kept their hair long to fit in better with the Native groups they had contact with. In 1784, men with short hair came from the Montreal Northwest Company, a rival company of the Hudson Bay Company. (Raczka, 1979). They were the first group of traders to have direct contact with the Blackfeet and in 1799 they built the Rocky Mountain House making it the main trading post to the Blackfeet (Hungry Wolf, 1989).

In 1801, there is a report among the Blackfeet that they had captured the stars and stripes (Raczka, 1979). It is commonly believed that Lewis, Clark, and their men were the first "Americans" to have contact with the Blackfeet but this report comes five years before Lewis and Clark were there. No one knows exactly who these people were but according to the Blackfeet's winter count (their written history) someone who would have had access to an American flag was in the area before Lewis and Clark. In 1806, the Piegans did meet the Lewis and Clark expedition. At this point of their trip, Lewis had split off from Clark. A fight broke out between Clark, his men, and the Piegans,

leaving one Piegan boy dead (Hungry Wolf, 1989). This is the beginning to bad relations with Whites.

Shortly after this in 1811, the Salish joined with some whites and attacked a group of Piegans, living by what today is Flathead Lake, MT, to gain access to the Blackfeet's land and buffalo (Raczka, 1979). This was the first time that the Piegans were defeated. Because of this, the Blackfeet were determined to wreak vengeance on Whites believing that they were now allies of their enemy tribes (Forbes, 1936). Although they now had a basic mistrust for Whites, they did allow some Whites to begin living amongst them, and in 1815, seventeen year old Hugh Monroe married a Piegan woman, making him the first white Blackfeet (Hungry Wolf, 1989). During these years there were many more outbreaks of disease not only amongst the Blackfeet themselves but also amongst the animals they lived on depleting their numbers yet again.

In 1825, General Henry Atkinson and Major Benjamin O'Fallou held a treaty council where other neighboring tribes signed treaties of amity with the United States. This allowed for white trappers and traders, and the United States government, to be able to move within these areas free of fear of retribution. The Blackfeet chiefs and elders did not appear at this because of their innate distrust of whites, although they never considered themselves at war with the United States (Forbes, 1936). Until the early 1830's, the Blackfeet were successful at keeping whites at bay because of their reputation of fierceness, but eventually the need for pelts outweighed the risks and trappers began pushing their way into Blackfeet territory. In 1831, the first American trading post on Blackfeet land, Fort Piegan, led by James Kipp was built at the mouth of the Marias River. On November 29 of that year, Kipp helped to officially establish friendly trading

relationships with the Blackfeet (Forbes, 1936). Sixteen years later, Alexander Culbertson, a trader married to a Blood woman, established Fort Benton (Hungry Wolf, 1989). This Fort became the most important trading post in Montana.

Over the next fifteen years the Blackfeet Nation suffered two more devastations. In 1837 another smallpox epidemic broke out, and this time it claimed the lives of over 6,000 Blackfeet, an estimated two-thirds of their population. Nine years later, in 1846, the Small Robes Band, members of the Piegan, were attacked and wiped out by the Crow (Hungry Wolf, 1989).

To prevent further hostilities, D. D. Mitchell, the superintendent of the Central Indian Agency suggested a council be held at Fort Laramie and on September 1, 1851 several tribes came together to discuss new treaties but again the Blackfeet did not show (Forbes, 1936). It was four years later on October 18, 1855 that Isaac I. Stevens negotiated the first treaty between the U.S. government and the Blackfeet at Fort Benton (Farr, 1984; Forbes, 1936; Raczka, 1979). Also known as the Lame Bull Treaty this treaty established nine things. One, friendly intertribal relationships were established between the Blackfeet, Gros Ventre, Salish, Kootenai, Nez Perce, and Pend d'Oreille, and ill feelings towards the United States were placated. Two, arranged boundaries were set giving the Blackfeet about half of Montana (Samek, 1987) and officially beginning the reservation era for the Blackfeet. Three, they were to treat visitors in the area peacefully, allow for construction of roads, railroads, and forts in their territory, and allow the open use of the waterways in their land. Four, the Blackfeet living on the reservation in Montana were no longer allowed to cross the border into Canada, although this was not controlled or followed well. Five, there would be no more hunting, it was time for the

Blackfeet to become “civilized”. Six, the trafficking of liquor was prohibited. Seven, individuals accused of crimes of robbery or murder were to be turned over to the United States government and in turn the government would punish Americans committing the same crimes against the Blackfeet. Eight, they were to turn over any American captives. Nine, the U.S. government would give gifts and an annuity of $15,000 a year for ten years to the Blackfeet to “civilize” (Forbes, 1936).

Overall the main plan was to move the Blackfeet away from white settlers and to mold them into law abiding Christian farmers. During the next decade the Blackfeet population remained steady at around 9,000-10,000 individuals in the three tribes. The area north of the Missouri, Teton, and Marias Rivers, was occupied by the Piegan, while the Blood and the Blackfeet ranged from East to West between the heads of the Milk and Marias Rivers, northward into Canada (Forbes, 1936). The annuity from the United States was not nearly enough to live on, only being a few dollars per person a year. Most of the Blackfeet were now living almost entirely on bison, but with the numbers of bison dwindling due to increased hunting, they were living in a feast and famine cycle. Some Blackfeet tried farming but the reservation land was not fertile and yielded very few crops. Most abandoned their farms after failed attempts to grow crops. Little Dog, Chief of the Blackfeet at this time, was determined to show his fellow tribesman that farming could be done but was no more successful than anyone else and soon left his farm to rejoin his people. By 1864, farming was deemed a failure (Forbes, 1936).

In 1865, the boundary treaty of 1855 was ratified removing the Blackfeet from the land south of the Missouri River. This reduced their land by 2,000 square miles and provided them one million dollars. It also allowed white settlers in and gave the

Blackfeet money for education for twenty years (Hungry Wolf, 1989). The Blackfeet were getting restless. They felt as though they were keeping up their end of the treaties but the government was not adhering to theirs and small sporadic fights known as the Blackfeet War began breaking out over the next five years (Samek, 1987). In 1870, a Montana rancher, Malcolm Clarke, was killed by a group of Piegan, this time the government retaliated with indiscriminant killing of the Native Americans. Lead by Major Baker, they attacked the wrong group of Piegan making the Baker Massacre, as it was called, the only armed conflict between U.S. troops and the Blackfeet (Hungry Wolf, 1989). This created a public outrage and in 1870 humanitarians pleaded with the government to stop the annihilation of Indians and to try to find peaceful ways to "civilize" them (Samek, 1987). The Peace Policy had little effect in the West.

After the Baker Massacre, Chief White Calf urged for peace between his people, the white settlers, and the agents, because he feared more clashes would lead to the loss of more land and even extermination of his people (Farr, 1984). Although the Blackfeet were living in a restricted area no actually boundaries were set. Agent N. Pope feared that without set boundaries the Blackfeet could not be controlled (Forbes, 1936). In 1873, Edward Smith, Commissioner of Indian Affairs, recommended to President U. S. Grant the he set aside a reservation for the Native Americans living in Montana. An executive order was signed by Grant on July 15, 1873 and was sanctioned by congress on April 15, 1874 (Forbes, 1936). This pushed the southern boundary north again above the Missouri and Marias Rivers and put the Blackfeet on 21,651,200 acres of land with seven other tribes (Forbes, 1936). The Blackfeet were not consulted about this or paid anything for the land they were forced to give up.

In Canada the Blackfeet faired better. Overall Canada had better policies, an absence of warfare, a simpler administration, and a general amiable relationship between whites and Indians (Samek, 1987). Although the treaty in 1855 did not allow the Blackfeet to move back and forth between Montana and Canada the boundary was not enforced. The whiskey trade had become big in the region exaggerating problems between the whites and the Blackfeet and leading to deaths of the Blackfeet due to alcoholism. Agents were employed to patrol the border between Canada and Montana but it did little to help (Forbes, 1936). On September 12, 1877, Treaty #7 was signed (Raczka, 1979). This meant that there was no more crossing the international line. The Blackfeet and the Blood were living in Canada at the time and chose to become part of Canada (Samek, 1987). The Piegan lived on the border of Alberta, Canada and Montana. Because of this, the Piegan separated into two groups the North Piegan in Alberta and the South Piegan (known today as the Montana Blackfeet) in Montana. The Montana Blackfeet were given their own reservation on May 1, 1888 (Forbes, 1936).

The 1870's and 1880's were a time of major changes for the Blackfeet. They were being forced to civilize and advances were made in healthcare, law enforcement, farming, housing, and education year by year. Although a doctor had been provided to the Blackfeet since 1864, many Blackfeet would not see him preferring instead their own medicine men, but by 1875 the overall health was good and many Blackfeet were now being treated by white doctors (Forbes, 1936). They were also becoming responsible for their own law enforcement. In 1875, three chiefs were chosen to represent the tribes; White Calf, Little Plume, and Generous Woman. 1878 saw the establishment of an

organized police department. And by 1881, the agency had left Fort Benton leaving the Blackfeet to police themselves (Forbes, 1936).

Several families decided to try farming again. In 1871, 75 acres were planted near the agency which yielded some crops. By 1872, seven families were farming but all of these families consisted of males of mixed descent. Also in that summer three houses were built for the chiefs to live in (Forbes, 1936). Although these farms were producing some crops the Blackfeet were not being taught how to farm. By 1880, with white expansion and open range cattle practice the bison disappeared from the plains and the Blackfeet were forced to learn how to provide for themselves (Farr, 1984; Raczka, 1979). By 1880, eighty-five families were now farming on 195 acres producing mostly vegetables but this was not enough to feed everyone through the winter months and the government rations did not meet their needs either leading to many deaths due to starvation. By 1887, the Blackfeet were finally becoming an agricultural nation (Forbes, 1936).

Education of the Blackfeet had not gone well. Even though the treaty of 1855 called for education of the Native Americans no schools were set up until 1871. In 1872, twenty-five native students attended regularly along with the white children of agency workers. In 1874, a boarding house was built so the children could stay there and attend school while their parents were “roaming” (Forbes, 1936). The girls were taught sewing, cooking, and housekeeping, while the boys were taught carpentry, blacksmithing, and farming. By 1876, eighteen Blackfeet could read English. By the early 1880’s over a hundred children were attending school regularly and learning not only to read English but to write it, too (Forbes, 1936). Over the years schools were added and expanded with

more and more children becoming "civilized." In 1890, forty-five Blackfeet children were sent to the Indian Industrial School in Carlisle, PA (Forbes, 1936).

In twenty-three years (1865-1887), the Blackfeet had gone from nomadic hunter-gatherers to sedentary farmers. "The civilizing of the Blackfeet appeared to be a slow process, but it necessitated that the Indian change from the chase to the farm, from the tepee to the house, from the medicine man to the physician" (Forbes, 1936:73). Entering the 1890's the old ways had come to an end and the four tribes: the Canadian Blackfeet, Blood, Northern Piegan, and Southern Piegan or Montana Blackfeet, began developing their own identities.

THE INDIAN INDUSTRIAL SCHOOL

The Indian Industrial School was founded in 1879 by General Richard H. Pratt in the small town of Carlisle, PA. General Pratt became interested in Native Americans when he was stationed at Fort Gibson in present day Oklahoma. There he was placed in command of Native American scouts (Pratt, 1908). Working closely with Native Americans led General Pratt to think about the conditions of minorities in a social and political paradigm. He believed that all men, including minorities, should have equal rights and believed that through education Native Americans could be transformed into equals (Landis, 1996; Pratt, 1908).

General Pratt's idea for a school for Native American children came to him when he was serving as a jailor at Fort Marion in St. Augustine, Florida from 1875-1878. There he was in charge of overseeing seventy-two Kiowa, Comanche, and Cheyenne leaders who were sent there as prisoners-of-war (Pratt, 1908). Although Pratt had a

fondness for Native Americans and believed in their equality, his military career was his first and foremost priority. He also had little use for their cultures. He believed that the basis for Native American inferiority was cultural not racial (Adams, 1995). Pratt saw this opportunity as a chance to educate the Native Americans; to give them the skills to compete on equal terms with Whites. He believed that society would accept Native Americans once they had given up their cultural identities and accepted "white" ways (Holm, 1979). He set up a school for them to learn trades, taught English to them, and even let them guard themselves which they did without incident (Pratt, 1908). After their sentences were completed General Pratt found many of the Native Americans had adopted White dress and habits and did not want to return to their reservations; they wanted to stay where they were and get jobs employing their new found skills.

The end of the 1870's seemed like the perfect time for Pratt to start his school. The fourteenth and fifteenth amendments to the constitution had recently been added giving citizenship to all people born in the United States and giving them the right to vote respectively. The majority of Native American tribes were on reservations at this time and had lost their independence. Most of these reservations had schools on them which Pratt believed were inferior because he thought that if left on the reservations Native Americans would continue to lead their "savage" lifestyles (Holms, 1979). The schools on the reservation were still "Indian" schools. On them "civilization" was a theoretical concept that they could not really experience (Adams, 1995). Pratt felt the children should be moved away from the influences of their families and the reservations. His school would be the midway point where they could be away from the reservation but not yet involved in "American" life and when the children had become "civilized" he could

mainstream them by placing them into public schools. His school would accomplish four things; it would give children usable knowledge of the English language, teach them a skill in an industry that would enable them to successfully compete in the "White" world, give them the courage to "civilize" enabling them to abandon their tribe and live successfully among "civilized" people, and lastly give them an education (Pratt, 1908).

General Pratt went to the secretary of war proposing his idea for an Indian school and asking for 250-300 youths to teach so he could demonstrate that through education these Native American youths could become "civilized." He proposed using an old military base, the Carlisle Barracks, in central Pennsylvania, that had been vacant since 1872 (Landis, 1996; Pratt, 1908). He was told that first he must get permission from the town of Carlisle, which accepted the idea with open arms, and then he must get permission from the Indian Agencies to take Native children, which took some convincing on his part. He first stopped at the Dakota Agency where he hoped to collect seventy-two Sioux children but when he arrived he quickly ran into opposition from Chief Spotted Tail who said, "The white people are all thieves and liars, and we refuse to send our children, because we do not want them to learn such things" (Pratt, 1908: 16). Pratt was ready with his response, "Spotted Tail, you are a very distinguished man…but Spotted Tail, you cannot read and write. You sign papers and you do not know what you sign. You know very little about the large interests of your tribal property and what is best for the people over whom you are placed simply because you have no education….lacking in education and experience in our affairs you are not able to protect the interest of your own people…Spotted tail, you have many children, give me some of them, and let me take them to Carlisle and teach them our language, how to read and

write and do business as we do, so that they may come back and help you in your position as chief of this people." (Pratt, 1908:17-20). The chiefs were convinced and gathered up eighty-two children to make the journey to Pennsylvania.

The school opened on November 1, 1879 with one hundred forty-seven children from seven tribes in attendance (Landis, 1996). The school was run military style, learning academics half the day and a trade the other half. All children were taught reading, writing, arithmetic, geography, music, drawing, composition, and bookkeeping. In addition, the girls learned household economy, needlework, cooking, and sewing while the boys learned farming, carpentry, blacksmithing, wagon making, and printing (Landis 1996; Pratt, 1908). Children were organized into companies with officers being chosen amongst them. They kept children from the same tribes as separate as possible to stop them from speaking their native languages. Also on arrival their hair was cut, uniforms were issued, and new "American" names were given forcing them to give up their tribal identities (Adams, 1995). The kids were also subjected to strict military discipline and a court of their peers was instituted to advise on disciplinary actions. A Sunday school was also established at the school but well-behaved boys were often sent out to local churches to attend Sunday school with their white peers. During the summers some of the children were sent out to local towns to work and live with whites, which some critics looked as a nothing more than a training ground for domestic servitude (Holms, 1979). By its second year the school had grown to 295 children from twenty-four tribes in attendance (Pratt, 1908).

Although General Pratt had many supporters there was also opposition to his Indian Industrial School from several institutions including the Bureau of Indian Affairs

and the Smithsonian whose “anthropologist glorified native values and ridiculed the possibility of swift culture change” (Pratt, 1908:6). Their thinking was that the reservation was still the best place for these children. Some looked at Pratt’s school and boarding schools in general as a way to destroy Native American culture (Holms, 1979) After twenty-five years as Superintendent of the Indian Industrial School General Pratt was forced to retire in 1904 due to strong opposition. but he still pushed his stance from his home in Rochester, New York writing letters to the President and the Bureau of Indian Affairs. By 1918, the BIA had successfully brought an end to the Carlisle Indian Industrial School. General Pratt died in the San Francisco Army hospital in 1924 at eighty-four years of age (Pratt, 1908).

As to whether the Indian Industrial School was a success or failure is a matter of opinion. If measured by the number of graduates that were mainstreamed Carlisle was a failure. Although it did its job in equipping its graduates with the skills to enter the “civilized” world, few did. Most returned to their respective reservations where they were accepted neither by their own people nor by the whites. Over 10,000 individuals attended the Carlisle Indian Industrial School in its thirty-nine years of operation (Landis, 1996).

CHAPTER II: LITERATURE REVIEW

In 1912, Franz Boas published his study on the effects of the American environment on bodily form. He wanted to end the idea of fixed racial classifications that at the time was very prominent. He collected anthropometric measurements on European Immigrant parents and their children born in the United States to prove that racial categories were not fixed because the environment had some control over an individual's development. His study of plasticity focused on the difference between American-born children of European descent and their European-born parents.

Boas began this study in 1908 and for two years, he and a group of assistants collected anthropometric measurements on 17,821 immigrants and their children living in the New York area (Gravlee, 2003a). The data included head length, head breadth, facial breadth, stature, eye color, and hair color. There were seven ethnic groups accounted for: Bohemians, Central Italians, Hebrews, Poles, Scots, Hungarians, and Sicilians. The Eastern European Hebrews were his largest represented group with approximately 6,000 individuals in the study. Only about 5,500 individuals were over the age of twenty-five the rest being between four and twenty-five. Those born in the United States accounted for about forty percent of his data.

Boas was mainly interested in how the cephalic (or cranial) index was affected by changes in the environment. Cephalic index is the ratio between head breadth and head length and at the time was thought to be the most stable. Boas showed that the individual races in Europe were distinct but their children born in the United States had an intermediate head form. He stressed that not all changes occurred in the same direction,

the only uniform change was in face width which decreased as a result of the influence of the American environment.

Boas also wanted to test if differences in head form became more pronounced with increased exposure to the American environment. He split the children into those born within ten years of their mothers' immigration and those born more than ten years after their mothers' immigration. He compared the two groups with children born in Europe and found that the greatest change occurred in the children who were born more than ten years after their mothers' immigration. His comparisons showed that between American-born and foreign-born children, cephalic index, "undergoes far-reaching changes due to the transfer of races of Europe to American soil" (Boas, 1910:7).

Lastly, Boas compared the children to their parents. Boas reasoned that if differences between immigrant parents and their children born in the U.S. were greater than differences between immigrant parents and their European-born children than that would be additional evidence of the influence of the American environment on head form. His results show that differences in cranial index between parents and their children were greatest when the children were born in the United States. The differences also increased between parents and their children when the children were born more than ten years after immigration echoing his previous results. Until his death in 1942, Boas continuously defended, clarified, and refined his study in a series of publications finally publishing his raw data in 1928 so it would be accessible for all to study (Gravlee, 2003a).

After Boas' results were published a new wave of studies focused on the effect of the environment on human growth and development. These studies compared immigrants

to their children, immigrants to nonimmigrants, and assessed the effects of growth and development due to variations in the same environment. In them, each author attempted to discover just how the plasticity of the human body reacts to different environmental changes. In her 1954 article Bernice Kaplan reviewed twenty-five studies and summed up their findings discussed below. Like Boas, several authors also set out to compare immigrants and their children looking at Hebrews, Japanese, Mexicans, Germans, and Chinese. Guthe's (1917) study of Hebrews from the Boston area echoes Boas data for the New York Hebrews finding a general increase in stature and a reduction in cranial index between Russian-born Jews and their American-born children.

Others, such as Spier (1929) and Ito (1942) compared immigrants to their counterparts still living in their native lands. Spier (1929) looked at Japanese children born in America and Japan. As had Boas, he found that the longer a mother resided in America the more likely her American-born children would have longer, broader heads. Ito (1942) was interested in looking at the rate of bodily growth. He also looked at the Japanese but focused only on women. He separated them into four groups: those born in Japan, those born in the United States, those who were born in Japan but came over to the U.S., and those born in America who returned to Japan for schooling. The women born and raised in the U.S. reached adult dimensions the quickest followed by the group that was born in Japan and immigrated to the United States before the end of the growth period. The slowest to develop were the females that were born and raised in Japan.

Bowles (1932) looked at three generations of male Harvard students. All students were measured when they entered Harvard as freshmen eliminating age as a factor. He also compared his results to mothers and daughters that went to other colleges like Smith

and Vassar. In both sexes, stature and weight increased with each successive generation and the changes were almost proportionally similar.

Others have attempted to focus on different environmental influences to see which effects growth the most. This is difficult because it is hard to separate direct influences of the environment such as temperature, altitude, and amount of sunshine received from indirect influences, like available food and work habits. Ivanovski (1923) studied the effects of famine on Russians after World War I. He collected anthropometric data on 2,114 individuals from all over Russia. Individuals were measured every six months over three years. He saw marked decreases in all dimensions studied including: stature, head length, horizontal circumference of the head, cranial index, facial width, facial height, nasal length, nasal width, sitting height (trunk length), arm length, and weight. Most individuals suffered their maximum loss in statue within the first year of famine and after their diet became regular again, most returned to their prefamine height. Ivanovski concluded that the lack of adequate food permanently effects physique. His study helped shed light on the immediate biological effects of a drastic modification of the environment.

Most of the authors Kaplan reviewed agree that the changes in bodily dimensions are not evolutionary in nature but an individual response to a particular environment. This should make it possible to identify what facet(s) of the environment are responsible for changes in growth but there still is little agreement as to which factors are responsible for those changes.

In 2002, two different sets of researchers used Boas' 1928 raw data with modern statistical analyses to test if Boas' 1912 conclusions were right. Sparks and Jantz (2002)

used facial breadth, head breadth, and head length and concluded that the differences between European Immigrants and their American-born children were not as great as Boas found. They hypothesize that the differences between parents and their children and between U.S.-born and European-born children are inconsequential compared to the differences between the ethnic groups, and that the effect of the environment on cranial form is trivial. They used univariate t-test and least-squares regression to test differences on over 8,000 individuals among the different ethnic groups.

The t-tests were used to assess differentiation in the three raw variables (head length, head width, and facial width) and the cephalic index between American-born and European-born children of the same age. They calculated z-scores for the variables by sex resulting in 448 tests and used an alpha significance level of .001. Of the 448 possible tests only 156 could be run because of small sample sizes. Eleven of the 156 tests show a significant difference between American-born and European-born children. Most of the difference can be seen in cephalic index, with a general reduction of cephalic index in American-born children between the ages of 7 and 14.

Least-squares regression was used to test the effect of duration of environmental exposure on cephalic index. Sparks and Jantz (2002) calculated environmental exposure as age for American-born children and difference between immigration year and 1910 for the European-born children. Also, a two-factor ANOVA was used to test for ethnic group (genetic effect) and birthplace (environmental effect) on the cranial measurements and the cranial index. The regression of cranial index on age and environmental exposure show little effect of environmental exposure on cephalic index. In Scottish males there is a slight increase in cephalic index in response to time in America while in Polish females

there is a slight decrease. Sparks and Jantz state that the data shows a more significant effect from age rather than time of American residence on cephalic index and suggests that overall cranial index is stable in response to a changing environment. The results of the ANOVA indicate that the differences in the variation between American-born and European-born individuals are dependent on the ethnic group (genetics) and not birthplace (environment). Yet they do note birthplace has a slightly higher but still insignificant effect on facial width.

Based on their results, Sparks and Jantz attribute much of the cranial variation to genetics and little variation to environmental influences. As they state, "In America, both Blacks and Whites have experienced significant change in cranial morphology over the past 150 years but have not converged to a common morphology as might be expected if environmental plasticity plays a major role" (Sparks and Jantz 2002:14638).

Clarence Gravlee, H. Russell Bernard, and William Leonard (2003) came to a different conclusion from Sparks and Jantz (2002) in that they believe Boas was right. They state that Boas stressed that not all change occurred in the same direction and the only uniform directional change was in face width. They first tried to find errors in Boas's original data. Possible socioeconomic differences in European-born and American-born children could be a factor but Gravlee and coworkers say that it would not affect parent-offspring comparisons. Interobserver error was another possible problem, since Boas had thirteen graduate students helping him collect data, but even Boas' biggest critics agree that Boas was meticulous and interobserver error was not an issue. The third concern was that in 1910 Boas originally reported measurements for over 17,000 individuals, over half whom were male and in his 1928 *Materials for the*

Study of Inheritance in Man, in which he published his raw data to answer critics, only 13,386 individuals were described, less than half being male. There exists no explanation for this and no one knows what happened to the missing data.

Gravlee and coworkers (2003) decided to test three of Boas' ten principle results from his 1912 article, which they regard as testable hypotheses. These are:

> H1: There are significant differences in head form between U.S.-born and foreign-born descendents of immigrants; these differences are not the same direction in all groups; they develop early in childhood and persist throughout life (Gravlee, 2003a:128).
>
> H2: The influence of U.S. environment on changes in head form increases with the duration of time elapsed between arrival of the mother and birth of the child; children born more than ten years after their mothers' arrival show greater differences in head form than those born within ten years (Gravlee, 2003:128).
>
> H3: There are significant differences in head form between U.S.-born children and their own immigrant parents; these differences are greater than those between foreign-born children and their parents (Gravlee, 2003:128).

To test hypothesis one, they modeled the effect of age, sex, birthplace, and immigrant group on cephalic index by using an analysis of covariance (ANCOVA). ANCOVA produced results that tested the main effect of birthplace at each level of immigrant group adjusted for age and sex. Because of missing data, they could only use 7,602 of 8,242 descendents of immigrants under the age of twenty-five. Following Boas' original data they separated individuals in to the seven ethnic groups to ensure compatibility.

The results of these tests show that differences in head form between U.S. and foreign-born children are slight and vary in direction of change. Yet when looking at results of each immigrant group separately, the four largest samples, Bohemians, Hebrews, Central Italians, and Sicilians, head form change is significant. But what about

the other three groups? Gravlee and colleagues believe that lack of significant change in those three groups may be because of small sample sizes.

Next they used ANCOVA and least-squared regression analysis to test Boas' conclusion that the influence of the American environment increases with the time elapsed between mother's immigration and the time of the child's birth. They separated the children into three groups: foreign-born, U.S.-born less than ten years after mother's immigration and U.S.-born more than ten years after mother's immigration. For these tests they had 6,585 individuals.

In two of the groups, Bohemians and Hebrews, significant differences in head form between the time elapsed since mother's immigration and the child's birth are seen, but only in these two groups. In fact, Gravlee and colleagues state that less than two percent of variation can be attributed to the time elapsed in America before the child's birth.

To test the third hypothesis, parent-offspring correlation's and regression coefficients were used to test that there exists a larger difference in cephalic index between American-born children and their immigrant parents than in European-born children and their parents. They compared each child's cephalic index to both their mother and their father's cephalic index and the mean of both their parents' cephalic index together.

They found that children born under the influence of the American environment are less similar to their parents in head form than foreign-born children are to their parents. They believe this corroborates Boas' overarching conclusion that cephalic index is sensitive to environmental influences. They conclude that for the most part,

> "…Boas was right, despite the limited analytical tools at his disposal. However, the strongest evidence that environmental factors influence the cephalic index is not the direct association between cephalic index and the time elapsed between mother's immigration and child's birth, as previously been thought. Rather, it is the difference in parent-offspring correlation's and regression coefficients between U.S.-born and foreign-born immigrant descendents and their parents" (Gravlee et al, 2003a:136).

In 2003, American Anthropologist gave each set of authors a chance to respond to each other. In *Changing Times, Changing Faces: Franz Boas's Immigrant Study in Modern Perspective,* Sparks and Jantz believe that because of the historical, social, and political setting of the time Boas may have overstressed the importance of his findings, and although some changes observed by Boas do have statistical significance, they lack biological meaning.

To understand what Boas was attempting to show one hundred years ago Sparks and Jantz believe at first you must understand the historical, social, and political environment of the time and understand the man himself. The early 1900's saw an increase of immigrants from Eastern and Southern Europe creating social pressure on the U.S. In response the Immigration Commission was formed. The American ruling class wondered about these new immigrants whose physicality was much different than the tall, blond type from Northern Europe. Boas questioned what affect the arrival of these individual would have. Would they, like their predecessors from Northern Europe, become amalgamated into the typical American physicality of the time? The government on the other hand worried more about social assimilation. Sparks and Jantz wondered if, because of the pressure from the government, Boas was looking at the data he collected as a way to show the U.S. government that any European could be assimilated into the American ideal socially as well as physically.

Next, Sparks and Jantz point out that although Boas findings were revolutionary at the time they were published, they have little affect on modern biological anthropology. They state that Boas' results have been exaggerated leaving little room for genetics in cranial growth and development. In Gravlee and coworkers (2002) article the greatest difference between foreign-born parents and U.S.-born children is 1.67 cranial index units. Sparks and Jantz believe this is hardly a change in type. In other words a difference of 1.67 would not result in a short-headed person becoming long-headed because of the American environment.

Gravlee, Bernard, and Leonard stated in, *Boas' Changes in Bodily Form: The Immigrant Study, Cranial Plasticity, and Boas' Physical Anthropology*, that they came to different conclusions from Sparks and Jantz (2002) because they were asking different questions and using different methods. They also believe that Sparks and Jantz differed with them on what Boas actually meant in his papers. Gravlee and coworkers point out that the fact that Sparks and Jantz could only use 156 of 448 t-tests was a problem. The fact that 11 of the test came out with a significant difference with an alpha level set that low, is proof that Boas was right.

Gravlee and colleagues point out, that their method shows, that in terms of cephalic index, U.S.-born children are less similar to their immigrant parents than foreign-born children are to theirs. This implies that when heritability is calculated separately for each group there is a lower estimated heritability for cephalic index of American-born children because of the environment.

Gravlee and colleagues also thought that Sparks and Jantz misconstrued Boas' statements and over dramatized what Boas meant by the effects of the environment.

Whereas Sparks and Jantz expected a major influence from the environment, Gravlee and coworkers knew that was Boas believed the environment had only a slight impact on cranial form.

Recent studies have used cranial dimensions through time to evaluate change in cranial form due to environmental differences. In 2000, Richard Jantz and Lee Meadows Jantz did a study on secular change in craniofacial morphology of American whites and blacks. They looked at the changes in the size and shape of the cranium and facial skeleton of individuals between 1840-1975.

They drew their 19th century samples from the Terry and Hammond-Todd collections and the 20th century samples from the Forensic Anthropology Databank. Five craniofacial measurements were used: glabella-occipital length, basion-bregma height, maximum cranial breadth, nasion-prosthion height, and bizygomatic breadth. The first three measurements characterize cranial vault shape and size, while the last two measure face shape and size. Secular change was analyzed by using polynomial regression.

Their results show that shape changes were more pronounced than changes in size. Overall, there is a lengthening and narrowing of the cranial vault, while the face goes through the same changes but less marked. Although American blacks and whites have not converged to a common morphology (Sparks and Jantz, 2002), they do exhibit the same directional trends under the influence of the American environment.

CHAPTER III: MATERIALS AND METHODS

In order to test the validity of cranial plasticity, a sample was drawn from Boas' Native American data. The data were analyzed using RMET 5.0 to test the biological relationship between the three tribes of the Blackfeet Nation. Also, measurements of the head length, head width, and cranial index of the children on the reservation were compared to the children of the Indian Industrial School to test if the differences between the reservation and Pennsylvania effected the growth of their cranium. Lastly, the adults head length, head width, and cranial index were calculated and compared to test if there is an overall change in the head form of the Blackfeet Nation over time.

Boas collected anthropometric data on American Indians from 1890-1911. The data was collected for the 1893 World's Columbian Exposition in Chicago, to develop exhibits showing the physical variation among Native Americans (Jantz, 2003).

Boas and his meticulously trained observers measured over 15,000 Native American subjects from over 200 tribal groups. He recorded six measurements of the head and face and six measurements of the body. The data also included information about fertility (number of children living and deceased), genealogical information, birthplace, and admixture with native and non-native populations (Jantz, 1992, 1995, 2003).

At the time, Boas did not do much with this information and after his death, it was lost. The database was discovered at the American Museum of Natural History in 1983 with help from Richard Jantz. Since then some studies have been done using this rich supply of information; from anthropometric variation studies (Wescott and Jantz, 1999)

to blood quantum studies (Moore and Campbell, 1995) and Jantz is encouraging more anthropologist to study it with new eyes.

The data for this study consists of 217 individuals from the three tribes (Blood, Blackfeet, and Piegan) collected from Montana, Canada, and Pennsylvania (Table 1). The data was collected from 1891-1892 by Franz Boas and his highly trained students. There are 170 males and 47 females in the data, with 122 individuals being Piegan, 66 Blood, and 29 Blackfeet. Their birth years range from 1807-1888 with a mean birth year of 1870 and an age range of 4 to 85 with a mean of 21 years at the time of observation.

Table 1. Total number of individuals in sample

	Male adults	Female adults	Male children	Female children	Total
Piegan	45	10	32 (18)	10 (7)	97 (25)
Blood	7	3	41	15	66
Blackfeet	7	0	20	2	29
Total	59	13	111	34	217

Note: numbers in () reflect number of children from the Carlisle Indian School

The data set contains thirteen measurements taken on living individuals. These measurements are; standing height, shoulder height, finger height, finger reach, sitting height, shoulder width, head length, head breadth, face height 1, face height 2, face breadth, nose height, and nose breadth. Also recorded are identification number, sex, observer, observation place, observation date, last name, first name, age, tribe, purity, birthplace, mother's tribe, father's tribe, occupation, who they are the child of (if the parents are also in data), and how many sons and daughters they have both living and dead.

There are one hundred and forty-five children in the data with twenty-five children being observed at the Indian Industrial School in Carlisle, PA. These children range in age from 11 to 21 years old. From the reservation there are 120 children aged 21 and under. All individuals under 21 in the reservation group were used to maintain consistency with the age range of the Carlisle group.

For this study, since cranial plasticity is being investigated, only the six measurements taken on the head and face, tribe, sex, age, and observation place were used. Face height 1, a measurement of hairline to chin, was only taken on the Carlisle children and is not consistently measured, so it will not be used in this study. Head length (HL) is measured as the maximum length of the head. Head breadth (HB) is a measurement of the maximum width of the head. Facial height 2 (FH2) is the distance from nasion to chin. Face breadth (FB) is measured as the distance between zygomatic arches. Nasal height (NH) is measured from the nasion to the subnasal point. Nasal breadth (NB) is the width of the nose between alae (Boas, 1912). Birth year was calculated by subtracting age from observation date and was included with the anthropometrics.

In order to identify if differences exist in the cranial morphology among the adults of the three groups, a genetic distance analysis was conducted using RMET 5.0 by John Relethford. RMET uses z-scores for the six variables to test the biological relationship between the three tribes. Males and females were pooled to produce adequate sample sizes. To account for sexual dimorphism, z-scores were calculated by sex. Heritability, a measurement of the proportion of trait expression due to genetics, was set at .42 based on the average heredity calculated by Konigsberg and Ousley (1995).

Population sizes were obtained from the Handbook of North American Indians (Sturtevant, 2001), which provides an estimate of each tribes population size from censuses during the late nineteenth century. Table 2 shows the number of adults used in this analysis and the estimated population sizes from the 1885 census.

Table 2. Adult population used in RMET analysis

Population	size	size
Piegan	55	3100
Blood	10	2800
Blackfeet	7	2400
Total	72	

In order to assess if differences exist between the reservation children and the Carlisle School children the averages for each variable (head length, head width, and cranial index) were calculated using all individuals born in each birth year and measured in each observation place and then plotted. Only individuals that were born between 1870 and 1879 were used to keep the reservation group consistent with the Carlisle Indian School children. The Carlisle children are not being assessed to see if taking them to the Indian School in Pennsylvania caused them to look more like the "American" type of child; but to assess if moving them to a different environment (a Pennsylvanian boarding school versus the reservations in the West) caused any changes in their cranial form compared to their counterparts on the reservations. Averages for the three variables were also calculated for all the adults born before 1870 and plotted to show if there is an overall change in the head form of the Blackfeet Indians over time. Because the female samples for both the children and the adults are small they were not be used; only the males will be used.

CHAPTER IV: RESULTS

The RMET analysis of all adults produced an unbiased Fst of .114723 with a standard error of .034065. Fst is the proportion of total variation that is due to population subdivision (Relethford, 1994).

The Relethford-Blangero analysis conducted by RMET assessed observed within group phenotypic variance as compared to expected and the results are shown in Table 3.

Table 3. Results of Relethford-Blangero Analysis (Relethford and Blangero, 1990)

		Within-group Phenotypic Variance		
Population	r(ii)	Observed	Expected	Residual
Piegan	0.011555	0.989	1.137	-0.148
Blood	0.098790	0.903	1.036	-0.134
Blackfeet	0.266573	1.190	0.843	0.347

Table 3 provides the diagonals of the R matrix which provides an estimate of genetic kinship to the contemporary region (Relethford and Blangero, 1990). R(ii) provides the genetic distance to the regional centroid, the observed and expected heterozygosity of each population, and the residual variance (observed variance – expected variance). It shows that the Piegan and the Blood have experienced less gene flow than expected while the Blackfeet have experienced greater gene flow.

Table 4 shows the number of individuals in this study, the number of individuals of each tribe who are of mixed ancestry, and the percentage of the total that these individuals make up. This table indicates that the Blackfeet sample has a greater percentage of admixed individuals which may explain part of the Relethford-Blangero results.

Table 4. Admixture among the three samples

	Number of individuals	Number of mixed individuals	Percent
Piegan	55	11	20%
Blood	10	1	10%
Blackfeet	7	2	28.5%

Figure 1 shows the three tribes plotted by their first two eigenvectors (scaled by the square root of their eigenvalues) and is essentially a genetic distance map. The plot shows that the Blood and the Blackfeet are the furthest apart genetically. The Piegan are in the middle though they are more genetically similar to the Blood than the Blackfeet.

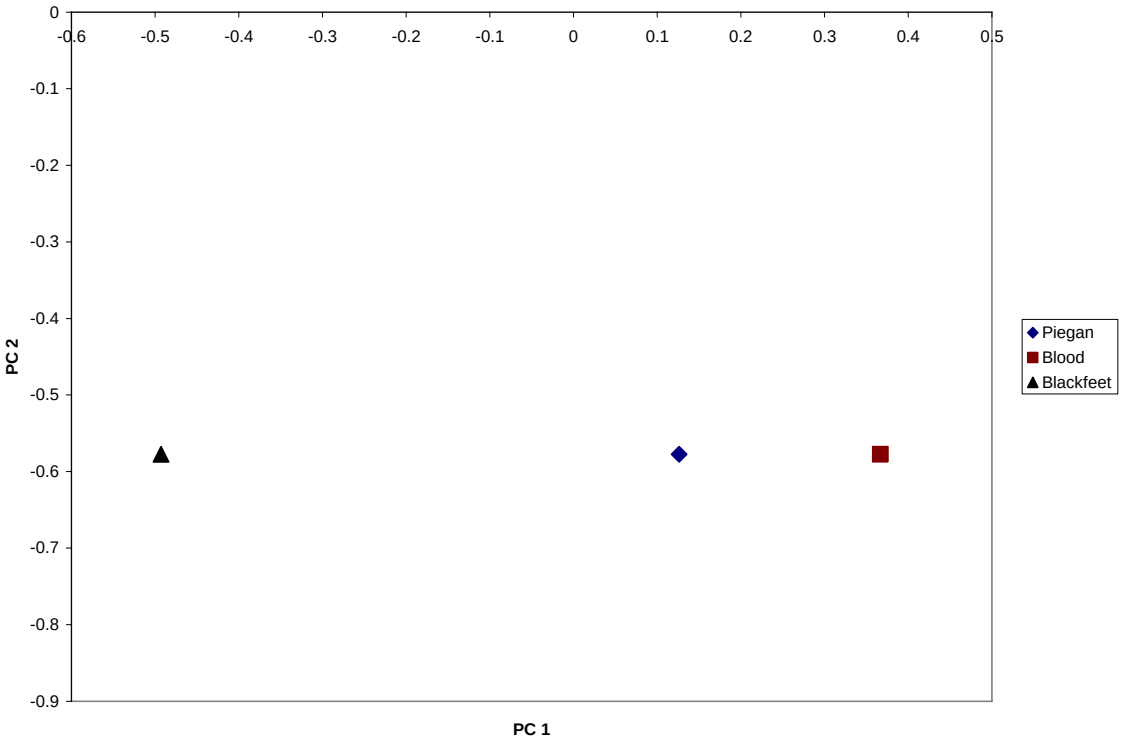

Figure 1. Genetic distance map

Table 5 shows the Mahalanobis distance (D^2) matrix. Like the genetic distance map it shows that the Piegan and the Blood are genetically the most similar with the smallest distance (0.041529) and the Blood and the Blackfeet furthest apart genetically with the greatest distance (0.737663).

Table 5. D^2 Matrix

	Piegan	Blood	Blackfeet
Piegan	0	.041529	.373891
Blood	.041529	0	.737663
Blackfeet	.373891	.737663	0

The chart in Figure 2 depicts the average head length of the reservation boys and the Carlisle Indian School boys by birth year. It shows that there are no discernable trends in the differences between the two groups. Note that in Figure 2 as well as Figures 3 and 4 there are no individuals from the Carlisle group born in 1873.

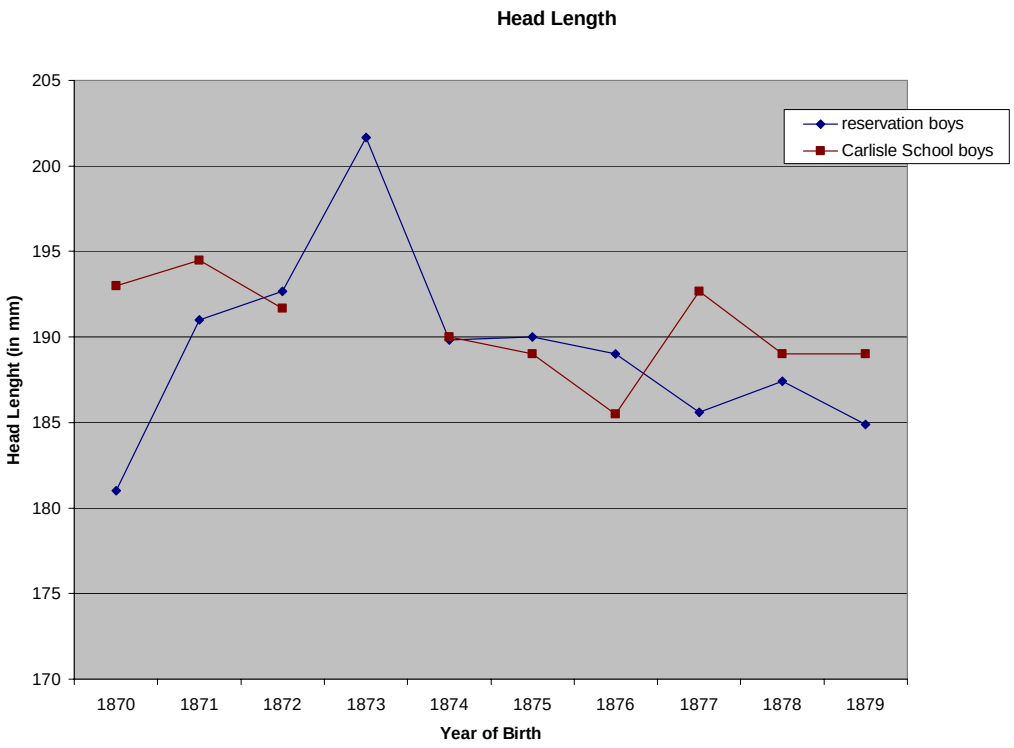

Figure 2. Plot of average head length by birth year for boys from the reservation and boys at the Carlisle Indian School.

The chart in Figure 3 shows the average head width of the reservation and Carlisle Indian School boys by birth year. The averages appear to by randomly patterned and show no obvious differences between the two groups or any temporal trend.

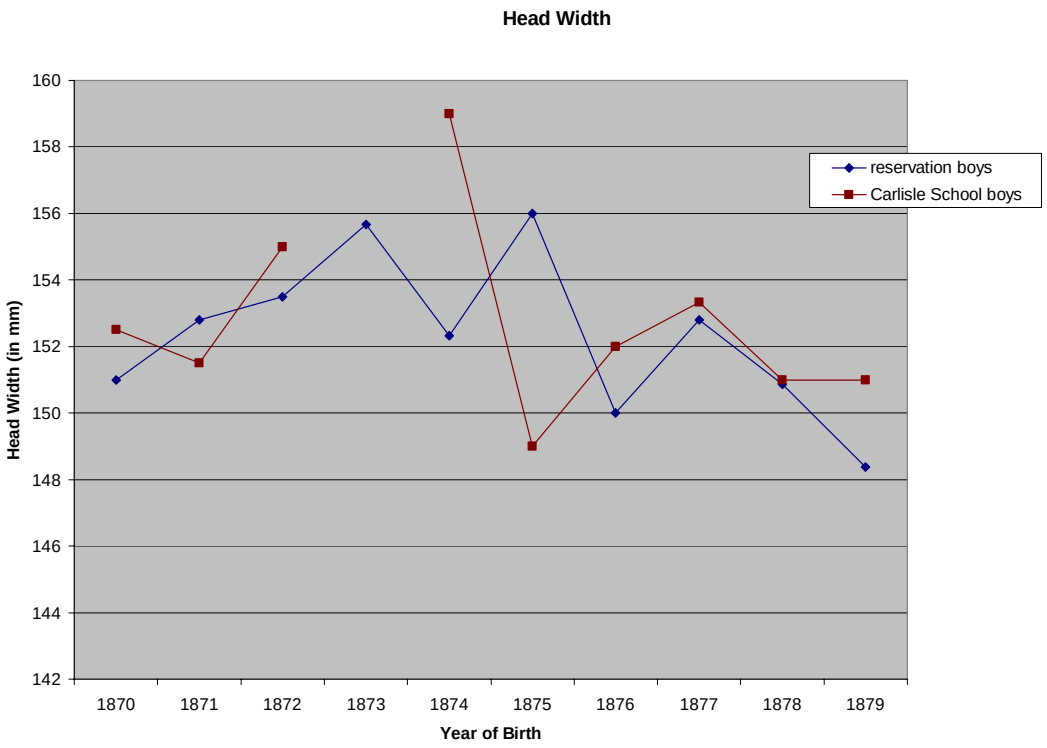

Figure 3. Plot of average head width by birth year for boys form the reservation and boys at the Carlisle Indian School

The graph in Figure 4 shows the average cranial index of the Carlisle Indian Industrial School boys and the reservation boys by birth year. Again the averages fluctuate randomly and no discernable patterns emerge.

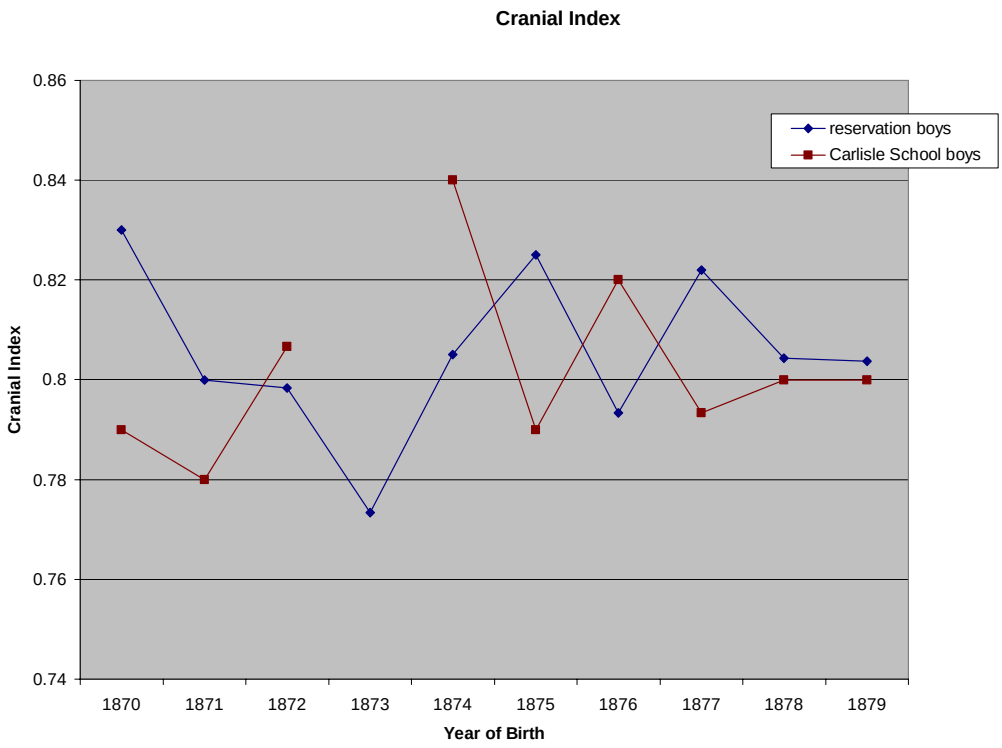

Figure 4. Plot of average cranial index by birth year for boys from the reservation and boys from the Carlisle Indian School

The graph in Figure 5 shows the adult males average head length by birth year. It shows that over time there is no pattern of change in head length. Note that there are gaps in Figures 5, 6, and 7 were no individuals are represented for those years of birth.

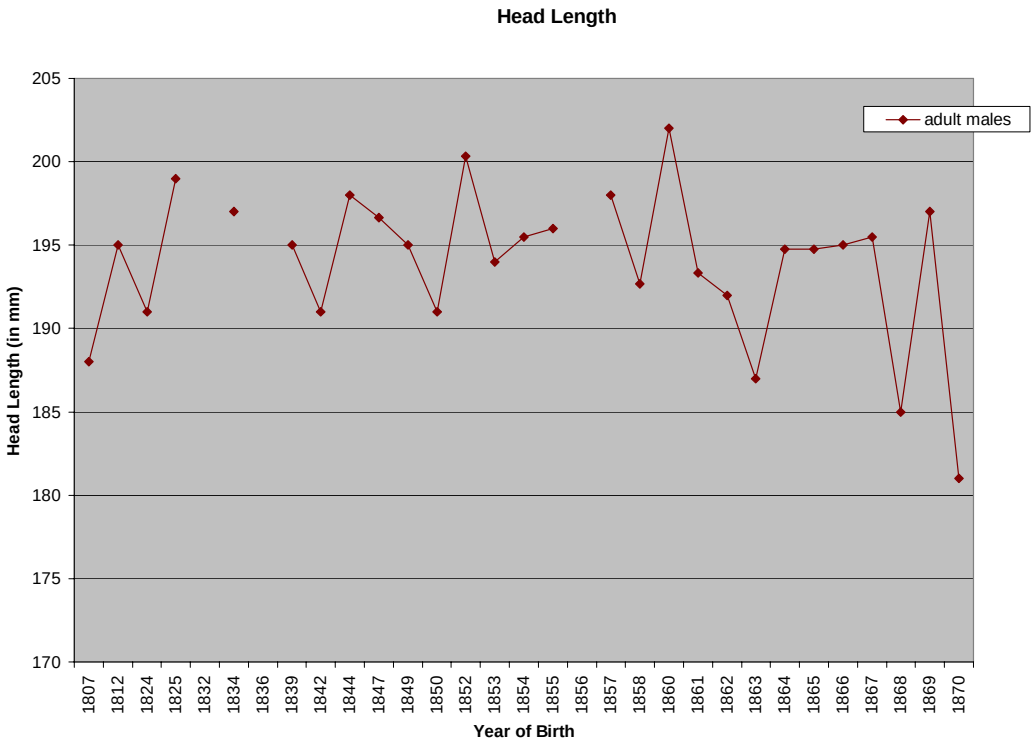

Figure 5. Plot of average adult male head length by birth year

The graph in Figure 6 shows the average adult male head width by birth year. Similar to the previous graph, head width averages change randomly and no noticeable pattern can be detected.

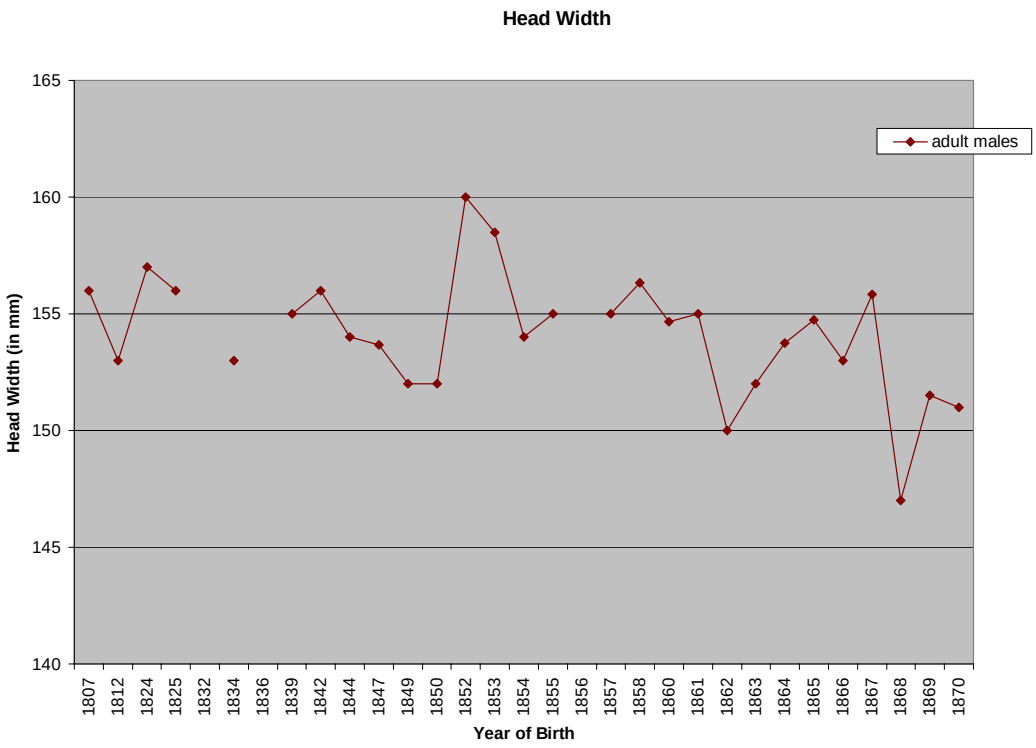

Figure 6. Plot of average adult male head width by birth year

The graph in Figure 7 shows the average cranial index of the adult males by birth year. The averages fluctuate randomly and no trend can be seen in cranial index over time. There are outliers at .83 for the birth years of 1807 and 1870. Each of the two birth years is represented by one individual and is most likely due to individual variation.

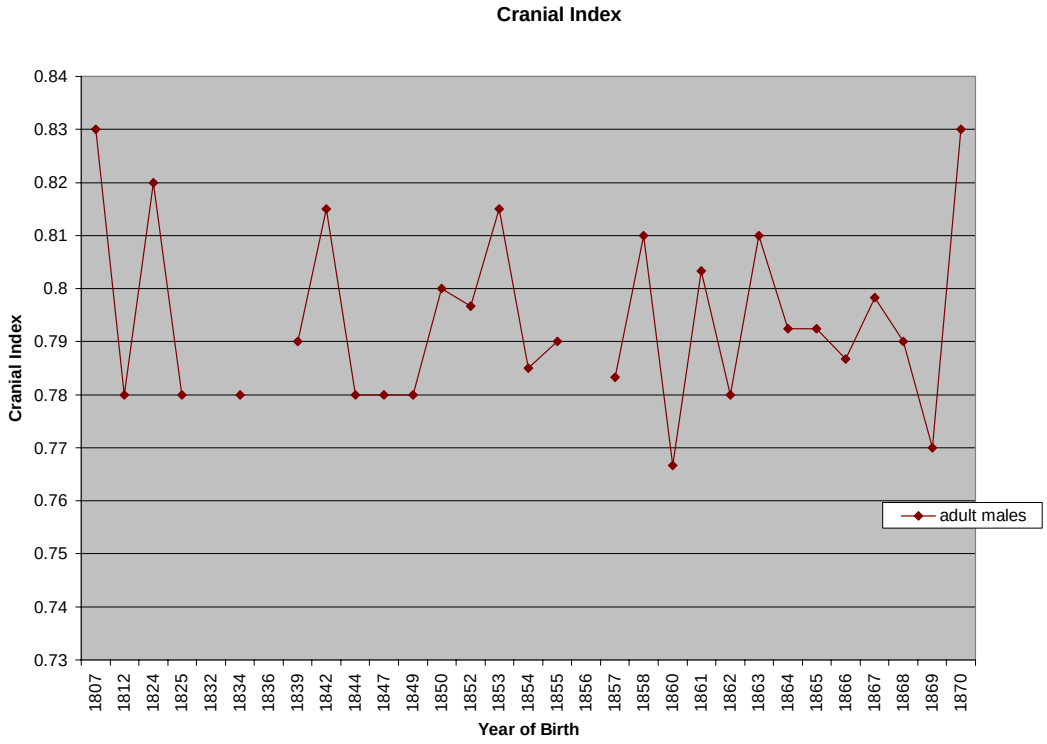

Figure 7. Plot of average adult male cranial index by birth year

CHAPTER V: DISCUSSION AND CONCLUSION

First the biological and genetic relationship between the adults of the three tribes was analyzed using RMET 5.0. The Fst is .114723. This means that roughly eleven percent of the genetic variation in the Blackfeet nation is interpopulational. Previous studies have found that the genetic variation among human populations throughout the world ranges from about ten to fifteen percent depending on traits examined (Relethford, 1994). This means that there is more genetic variation between peoples of the same population than peoples of different ethnic backgrounds. Eighty-nine percent of the genetic variation among the Blackfeet is intragroup. Most of the genetic variation is between individual members of the tribe. The Blackfeet were not a genetically isolated tribe. They were known to take women and children from neighboring enemy tribes (Raczka, 1979). Plus as whites expanded into their territory they intermarried with the Blackfeet. This leads to the wide variation seen not only in individuals of the Blackfeet but throughout the world.

RMET analysis also provided an R matrix. An R matrix provides an estimate of genetic kinship. According to the Harpending-Ward model (1982) populations that have higher than expected heterozygosity have experienced greater than expected gene flow. The Piegan and the Blood have lower than expected gene flow (-.148 and .-.134 respectively). The Piegans are the largest subdivision of the Blackfeet Nation and expand from Northern Montana into Canada. Because of this it is more likely that they married within their own population leading to a decrease in gene flow. Also, of the fifty-five Piegans in the data set the majority of them are full blood with only eleven being mixed.

Less admixture with outside populations can result in decreased variation. The Blackfeet, on the other hand, experienced .347 more gene flow than expected. In the data set two of the seven Blackfeet are mixed and with such a small sample size this may be why their gene heterozygosity is higher than expected. Also being a smaller population and being the farthest north in Canada they may have had more chances to mix with outside populations. In Canada there was more of an amiable relationship with whites which may have lead to more admixing.

RMET also provided a genetic distance map and a mahalanobis distance (D^2) matrix. These analyses show the genetic distance between the three populations. The genetic distance map shows that the Piegan and the Blood are the closest genetically with the Blackfeet being the furthest from both the Piegan and especially the Blood. Again the Piegan are the largest group and are found in both Canada and Montana thus increasing their chances to mate with members of the other two tribes. Also, in Canada the Piegan reservation and the Blood reservation are located close to each other with the Blackfeet reservation being way north. The Piegan and the Blood would have had more contact with each other than either did with the Blackfeet. This may explain why the Blackfeet are the furthest genetically.

Comparing the reservation children and the Carlisle children it appears that in most years the Carlisle children have slightly larger head lengths and head widths than the reservation children, though the difference is not significant. It is possible that at the Carlisle Indian School the children were receiving more nutritious food and better health care which could promote stronger, healthier, and therefore larger bones. All the children at Carlisle were of mixed descent whereas a lot of the reservation children were full

blooded. This may explain why slight differences exist. Also, head length and head width decrease throughout time which is due to the age of the individuals and not an effect of their environments. Because children do not fully develop until their late teens a twelve year olds head would not be as large as a twenty-one year olds head. As for cranial index, there seems to be no trend in the change over time.

For the adults there seems to be no noticeable trend in the change of head length, head breadth, and cranial index through time. There are a few slight decreases at certain times in all three graphs. In the late 1830's to early 1840's there is a decline. In 1837, there was an outbreak of smallpox that killed over 6,000 Blackfeet (Hungry Wolf, 1989). The decrease in cranial measurements of individuals born at that time could be a result of the effects of the epidemic.

There is another decrease in the late 1840's. In 1846, the Small Robes Band was attacked and wiped out by the Crows (Hungry Wolf, 1989). The loss of those individuals could have had an effect on the rest of the Blackfeet Nation.

Another slight decrease can be seen in all three graphs in the early 1860's. This is at the time when the bison had disappeared and farming was not a success (Forbes, 1936). Lack of adequate nutrition would have an effect on individuals born at the time but the decrease is slight and probably not significant.

Overall the main flaw of this study is the small sample size. For the children the differences between the two groups in only a few millimeters. Also, each age is only represented by a few individual if not one. Because of that these slight differences are probably more a result of the particular individuals and do not adequately represent the Blackfeet population at the time.

Sample size is also an issue for the adults. Only a few individuals are represented for each birth year, and there are many years for which there are no persons represented. So the slight changes throughout time are probably due to individual variation. Also, when running the data for the adults, all three tribes were pooled together. The RMET analysis has shown that some biological and genetic differences exist between the three tribes. Combining to produce a larger sample size could affect the results of the analysis.

Boas' data set also seems to have some inherent flaws. First there is an under representation of young children as well as adults over 65. It also seems to be biased towards males. Moore and Campbell (1995) feel that blood quantum is an issue. They state that the data set is biased towards employees of Indian agencies, their families and children of school age. They feel that because most measurements were taken at either Indian agencies or schools these individuals were more likely to be intermarried. The children in the data used in this study were mostly children of mixed descent. Essentially they were more elite then others in the reservation because they interacted with Europeans on a daily basis and were therefore more likely to intermarry. Because of this they also may have had access to better resources than the average population.

Another issue (Szathmary, 1995) is the accuracy of the measurements. Boas did not do all the measurements himself so there is the possibility of interobserver and intraobserver error. Although it is believed that Boas trained his observers well to minimize or eliminate this.

CONCLUSION

Based on the results of this study variations in the Blackfeet Nations' environment seemed to have little effect on head form. There is no evidence to suggest life at the Carlisle Indian School in Pennsylvania effected the growth of their craniums. Also, it does not appear that changing from a nomadic hunter-gatherer subsistence strategy to a sedentary agricultural lifestyle effected the growth of the cranium in a significant way. Therefore, as a result of this study, it appears that Sparks and Jantz (2002) may be right. That the effects the environment has on the growth and development of the cranium may not be as significant as Boas once thought.

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